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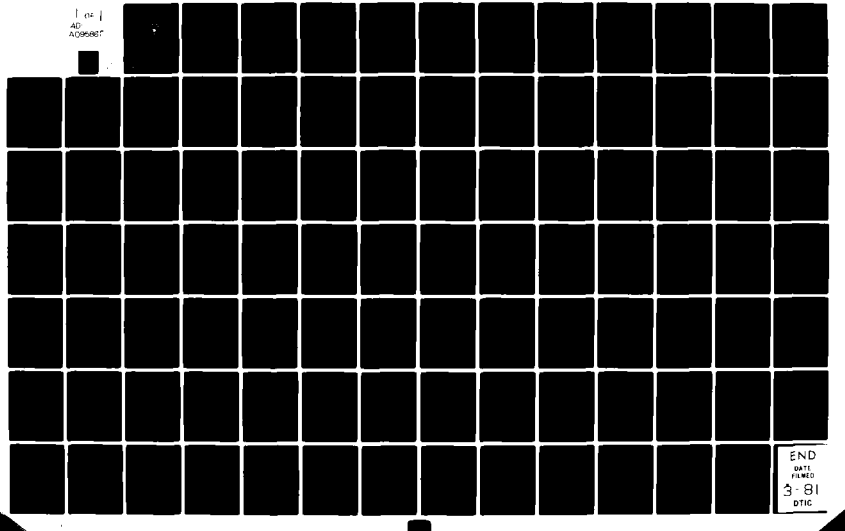

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NAVAL POSTGRADUATE SCHOOL
Monterey, California

THESIS

FREIGHT CONTAINERS IN INTERMODAL
AND LAND BRIDGE COMMERCE

by

James Stephen Walters

September 1980

Thesis Advisor: Dan C. Boger

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This thesis is a study of the freight container industry, a dominant participant in international and intermodal trade. A brief history of containerization is followed by an enumeration of the types of containers in use, the international standards applied to them, and the construction and modification of container carriers, ports and exchange facilities and container handling equipment. The land bridge, an intermodal concept dependent on containers, is traced historically through geological, biological and commercial applications. Governments,

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Freight Containers in Intermodal and Land Bridge Commerce

by

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Lieutenant Commander, Supply Corps, United States Navy
B.B.A., University of Iowa, 1969

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN MANAGEMENT

from the

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ABSTRACT

This thesis is a study of the freight container industry, a dominant participant in international and intermodal trade. A brief history of containerization is followed by an enumeration of the types of containers in use, the international standards applied to them, and the construction and modification of container carriers, ports and exchange facilities and container handling equipment. The land bridge, an intermodal concept dependent on containers, is traced historically through geological, biological and commercial applications. Governments, private entrepreneurs, labor organizations, regulatory agencies and the military services are active in influencing the industry. The future growth and expansion is linked to the cooperation and initiative which can be generated among these diverse participants.

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I. INTRODUCTION

Trade, like flowing water which seeks its own level, attempts to follow the path of least resistance in the movement of commodities from one location to another. Resistance along the path may take different forms. Geographical or physical obstacles, such as mountain ranges dividing a continent or a waterfall blocking river passage, may determine the avenues of commerce. Philosophical and cultural differences among neighboring people or of communities along a trade route may provide the impetus which generates costly deviations, or even the total cessation of trading activity between a supplier and a customer. Political considerations and the economic sanctions imposed by treaty or legislated fiat are often more significant than any natural barriers which formed through geological history or the human evolutionary process.

Advances in technology and the development of sophisticated, capable machinery and components provide clearances to many of the obstructions imposed by nature or governments. Aircraft of all descriptions fly over mountains, tunnels burrow through them, and four-lane, divided highways traverse their ridges and valleys. Bridges and subaqueous tunnels provide connecting links between otherwise separated land areas; and, conversely, canals and directed rivers provide a similar function for proximate bodies of water.

During the development and acceptance stages of innovative transportation or commercial concepts, resistance, in many forms, may

develop, which increases the length and breadth of barriers which must ultimately be surmounted. Impelementation of the concept will be delayed pending resolution of conflicts and elimination of objections or regulations which stand as impediments.

The transportation industry in general, and the cargo-moving part of that industry, in particular, is vulnerable to confrontation from a myriad of interest groups, based on any shift in procedure or attempt at change. Governmental influences are directed from two sources. The jurisdictional forces of the locale in which the specific industry or company attempts to create a change, come immediately to bear in the form of new interpretation of existing statutes or creation of regulatory guidelines to influence the changing environment. Additionally, governments of the entities which are subjected to constituent pressure to accept or reject new methods of operation will determine whether constraints are either erected, left intact, or removed.

Radical changes within a specific industry will create alterations in competitive patterns, forcing some participants to either accept the deviations or remove themselves from the field of players. The labor force associated with a rapidly evolving method of technology will often establish significant demands which must be met. Groups of people whose livelihoods are threatened by a changing business atmosphere feel compelled to guarantee that their jobs are secure and that they will be retrained within the context of the new modus operandi.

Customers will exert a tremendous influence on the acceptability, practicality, and feasibility of innovations. The customer may be the

ultimate consignee of the freight in question, or may be any of a number of intermediary material handlers or freight forwarders.

Legal impediments to progressive operation must be anticipated, overcome or appealed. Due to the emotion associated with implementation of new operational concepts, practices which have been validated by both precedent and judicial opinion may be challenged, tried and even reversed through judgemental or settlement actions. Any singular participant in the shipping industry or trade business may legally challenge and possibly disrupt or curtail a beneficial modification to the movement of freight.

The evolution within the frieght transportation industry toward containers has provided significant challenges, as well as absolute benefits for every portion of the global society which has been able to accept a revised and efficient means of movement. New methods of cargo shipment and expanding facilities for intermodal exchanges of cargo have been developed as a direct result of the dramatic shift in emphasis from break-bulk to container carriage.

The emphasis on containerization in the industrial world has radically changed the nature of the maritime shipping business in virtually every respect. Fleets of break-bulk ships have become obsolete, and have been converted to container carriers. Shipyards around the Northern Hemisphere have profited from contracts to build ships which are designed to carry containers exclusively.

Containers have diversified from the simple box to specialized carriers of specific types of cargo. Standardization of containers has

made them compatible with virtually any transportation mode and with nearly all container handling equipment.

Ports, terminals and exchange facilities have been converted or constructed on the basis that container volume would substantiate the financial involvement and operational development. The services which are available at ports such as New York and Oakland have led to a specialized form of intermodal shipment known as the "land bridge". The creativity and continual expansion evident in these services indicates that they are representative of imaginative competition as well as sound transportation business acumen.

Labor organizations, which are involved in every aspect of containerization, are as influential in directing the course of the industry as are financial experts and politicians. The most noteworthy group of labor participants are longshoremen and stevedores, who have closed ports and refused to move containers until they have been assured that they will share the wealth of a growing industry.

Regulation from within the industry, from international sanctioning bodies and from governments serves to channel the growth of the industry and maintain its competitive presence in the entire scheme of transportation and cargo movement. By following an orderly growth pattern, and adhering to policies which promote intermodal transport, standardization and evolution, containers are not only the cargo-moving method of the present, but of the future as well.

II. CONTAINERS IN INTERCONTINENTAL SHIPMENT

In a time period which is conincidental with the development of an extraordinarily complex program to explore the Earth's solar system, the galaxy and the universe, it would appear to be equally extraordinary that "...a box, with doors at one end or at the side, into which merchandise is packed,"[1] would revolutionize the intercontinental freight industry. The advent of the container, its standardization and its effect on shipping and associated ports is considered by seafarers and writers to have had an impact similar to that achieved when ships became self-propelled. A dramatic change in the cargo transportation industry was wrought when the economic desirability of containerized shipping was proven.

A. THE EXPANSION OF THE INDUSTRY

The introduction of containers to the maritime shipping industry was a logical progression from their earlier use in land-bound freight transportation. Additionally, the idea was implemented at a time when many factors were in perfect alignment to allow such a radical change to occur within the industry.

Small wooden containers had been carried by railroads as early as 1830, and wood and fabricated steel boxes had been regularly utilized

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[1]Munro-Smith, R., Merchant Ship Types, p. 137, Marine Media Management Limited, 1975.

by rail and motor freight shippers in the United Kingdom since 1926. The British Royal Commission on Transport reported in 1931 that,

> The use of containers is another direction in which we think greater progress might be made. The great advantages of containers, particularly in minimising the risk of damage and in reducing the cost of handling, are so obvious that it is a matter of some surprise to us that they are not more generally used.[2]

In retrospect, it is perhaps as surprising that the Royal Commission demonstrated the foresight embodied in that dissertation relating to over-ocean container shipping, as it was then that containerization had not been widely adopted. Many factors impeded the development and acceptance of containers as a wide spread means of moving raw materials or finished goods.

The great economic depression of the 1930s exerted two tremendous influences which initially stymied containerization. The shifting by any nation, business consortium or individual shipping company from the traditional break-bulk method of cargo movement to containerization would inevitably require an extensive capital investment in containers, container handling equipment, ships and port facilities. When a revised method of conducting business is initiated, it is advantageous for the entity which instigates the revision to be vertically integrated to be able to accomplish every facet of the initial implementation. Shipping companies and other freight handling organizations were destitute, if not bankrupt, as a result of the depression, and simply could not raise the extensive capital required to accomplish the conversion.

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[2]Johnson, K.M. and Garnett, H.C., The Economics of Containerisation, p. 12, George Allen and Unwin Limited, 1971.

Secondly, the depression caused a glut on the labor market which made it relatively easy for shippers and port operators to obtain the services of stevedores and longshoremen. Inasmuch as the traditional methods of moving cargo were heavily labor intensive, and since labor was readily and inexpensively available, there was little incentive for shippers to turn to containerization.

As the depression waned and the industrialized nations committed technology and resources to the military execution of World War Two, containerization was further delayed. It remained a fine idea, but immediate implementation was not crucial to the war effort. Battle conditions were not considered to be the best time to experiment with the replacement of tried-and-true methods of supplying American troops and allied governments with the commodities needed to pursue a military victory and subsequent reconstruction of war torn areas of the world.

The events of World War Two and the Korean Conflict were instrumental in ultimately creating an atmosphere which was conducive to the development of a containerized shipping industry. Most obvious of the factors was the decimation of the merchant marine fleets of most nations involved in the world war. Of secondary importance; however, was the fact that military planners and logisticians were well aware "...of huge stacks of crushed, torn, and weathered military supplies piled high on open wharves around the world..."[3]

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[3]Ebel, Francis G., "Evolution of the Concept and Adoption of the Marine and Intermodal Container" in Case Studies in Maritime Navigation, p. 5, National Academy of Sciences, 1978.

The introduction of containerization on the high seas was further delayed in 1946. The government of the United States played a direct role in this postponement by implementing the Ship Sales Act of 1946, which authorized the sale of excess military and other government-owned break-bulk cargo vessels at very favorable prices to the rebuilding merchant marine fleet of the United States. Therefore, the massive reconstruction efforts in Western Europe and Japan were logistically supported by the traditional break-bulk method of cargo handling.

The container era of ocean shipping dawned in 1956 when McLean Industries consolidated its wholly owned subsidiary, McLean Trucking, with its recently purchased Pan Atlantic Steamship Company to form a system of cargo handling which would allow door-to-door service between McLean customers in the area of New York City and those along the United States Gulf Coast and in Puerto Rico. In April of that year, McLean's converted cargo carrier SS Maxton carried a load of sixty containers from the Port of New York to Houston, Texas.

B. VARIOUS TYPES OF CONTAINERS AND THEIR USES

Like ships, barges, railroad cars and motor freight trailers and mounted truck bodies, containers may be modified to allow carriage of nearly any type of transportable commodity. Most specialized containers are adaptations of the standard, general purpose cargo containers which serve as the mainstays of the industry. A general purpose container is eight feet high, eight feet wide and twenty, thirty or forty feet long; permanently enclosed on three sides, the top and the bottom with a set of double doors for loading at one end. The container is

capable of carrying a load of dry cargo which is not heat sensitive and which will weigh, in combination, no more than thirty tons, the maximum weight which most container handling cranes are able to accommodate. General purpose containers are constructed from three basic types of materials: steel, aluminum, or fiberglass reinforced plastic laminated plywood. The choice of construction material, or combination of materials, must be based on the requirements of the user, the necessary amount of protection from weather and pilferage and the expected useful life of the unit.

Throughout the world, the container industry is widely dispersed among sixty-seven manufacturers representing twenty-one countries on both sides of the iron curtain. The various containers fabricated by a manufacturer range from the "total lineup" offered by giants such as Fruehauf of the United States and several Japanese firms, to single option or specially designed units available from several smaller European firms.

Among the specific types of containers in common use are:

Open-top containers. This design is convenient for heavy material which is more easily loaded into the container from the top using cranes and slings or pallets rather than end loading apparatus.

Refrigerated Containers. These containers require either a self-contained refrigeration unit or a hookup refrigeration facility at every stage of transport. They are utilized for shipping refrigerated or frozen drugs, chemicals, meats and other perishable foodstuffs. The temperature is normally adjustable to allow various refrigeration or freezer uses.

Controlled Temperature Containers. In an era when extensive shipment of sensitive electronic components and test equipment is commonplace, these well insulated transportation devices control internal temperatures, and make long distance shipping possible.

Heated Containers. During the cold seasons in many countries general purpose containers would allow too much damage to cargo from freezing, cracking and brittleness. Heated containers, which require either self-contained heaters or hookup facilities, provide an atmosphere which prevents extreme cold from affecting the cargo. In some areas of the world, a heated container will maintain a dry internal climate which serves to prevent or reduce mildew.

Ventilated Containers. Cargoes which can withstand atmospheric temperature, but which require a constant flow of fresh air to avoid an accumulation of moisture are shipped in ventilated containers. The ventilation may be free flowing through the container or it may be directed to specific areas by use of a ducting system.

Tank Containers. Within a structure which conforms to regular container dimensions, a tank may be constructed to allow the movement of liquid cargo in containerized ships, trains or trucks. The cargo may be fuel, beverages, or chemicals and the specific configurations will vary depending on requirements for pressure, sterilization and safety.

Shallow Tank Containers. For high density liquids, such as mercury, a shallow tank container which is less than eight feet high is utilized. This configuration allows the weight of the full container to remain less than thirty tons.

Gondola Containers. Bulk materials which are conventionally packed in drums, boxes, or crates are often shipped in gondola containers. The adjustability of these containers is their most attractive feature. The corner posts are telescopic to various heights and the wooden floors can easily be blocked to allow the loading of various quantities of variable sized material.

Automobile Carrying Containers. Although these containers are relatively self-explanatory when configured to carry automobiles, trucks or vans on their specialized ramps; the racks may also be adjusted to allow carriage of long lengths of lumber, pipe, metal bar stock, or finished iron and steel material.

Livestock Carrier. While typically used for shipping cattle and horses, these containers might be specially configured to carry nearly any type of live animals. They are constructed with windows, ventilation, food and water trays, and footlocks to prevent the animal from slipping due to the motion of the journey.

C. STANDARDIZATION WITHIN THE CONTAINER INDUSTRY

"International standardization is the rock on which container traffic is built."[4] Containerization without standardization would be similar to utilizing one seating plan to sell tickets for every baseball stadium in the United States.

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[4]Finlay, Patrick (Editor), Jane's Freight Containers, p. 597, Jane's Yearbooks, Franklin Watts, Incorporated, 1977.

Chaos within the container industry has largely been avoided due to the coordinating efforts of the International Organization for Standardization (ISO) which is located in Geneva, Switzerland. The 150 technical committees of the ISO attempt to provide standardization guidelines for all areas of technical endeavor. Such diverse general fields as aircraft, office machines, nuclear energy and documentation are monitored by the designated technical committees.

Technical Committee 104, addresses standarization of cargo containers. The committee is composed of thirty-one active member countries and ten more which have chosen designated observer status. In addition to the professional interaction among all ISO committees, Technical Committee 104 is continually advised by such member representatives as the American National Standards Institute of the United States, and numerous qualified international organizations.

ISO standards are published documentation which serve to unify such mundane aspects of the container industry as definitions, terminology (in the English, French and Russian languages) and physical marking requirements. The standards also distribute such technical data as dimensions (in both English and metric units); ratings or weights (in pounds and kilograms); specifications for construction, use and maintenance; and testing of various types of containers and their associated handling gear. Among the standards published for containers are:

ISO Standard 668-1973 - Dimensions and Ratings of Freight Containers. This publication actually and specifically defines a "freight container"

while also addressing ratings, classifications and designations. The definition of a freight container is:

A freight container is an article of transport equipment:

a. Of a permanent character and accordingly strong enough to be suitable for repeated use;
b. Specially designed to facilitate the carriage of goods, by one or more modes of transport, without intermediate reloading;
c. Fitted with devices permitting its ready handling, particularly its transfer from one mode of transport to another;
d. So designed as to be easy to fill and empty;
e. Having an internal volume of one cubic meter or more.[5]

Three general classifications or series of containers have been established by the ISO, with various container designations included in each, and with specific maximum weight ratings assigned to each designation. Among the series, Series One which includes containers from five to forty feet in length, contains seven designation groups and dictates the specifications for over-ocean or intercontinental trade.

Series Two and Series Three are each composed of three container designations and provide the guidelines for intracontinental international commerce. These containers are generally shorter in length than their Series One counterparts and normally weigh considerably less.

Each of the thirteen container designations is assigned a height, width and length with associated tolerances; and a rating. The rating is defined by the ISO as "...the maximum gross weight and is the maximum permissable combined weight of the freight container and its contents."[6]

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[5]Ibid.

[6]Ibid.

ISO Standard 1496-1975 - Minimum Internal Dimensions for General Purpose Series One Feight Containers. This standard is brief and very much to the point. As the title suggests it lists the minimum height, width and length dimensions in millimeters of a general purpose cargo container.

ISO Standard 1496 - Series One Freight Containers - Specification and Testing. The fact that parts of this standard remain unpublished is evidence of the relative youth of the container industry and of the attention it is receiving as it bursts upon the scene of international trade.

Five structural types of general cargo containers are identified in Part One of Standard 1496 (closed, including opening roof; open top; open side; open top/open sides; and open top/open sides/open ends) and the design requirements for the construction members and fitted appliances for each are specified.

The following tests are enumerated for this segment of the container production industry to indicate the lengths to which the ISO has developed procedures to foster homogeneity and safety:

> ...Stacking; Lifting from the top corner fittings; Longitudinal restraint; Strength of end walls; Strength of side walls; Strength of roof; Strength of floor; Transverse rigidity; Longitudinal rigidity; Lifting from the base at grappler arm positions; Weatherproofness.[7]

Part Three of the standard pertains to containers designed to transport liquids and gases, which require different design and testing specifications than do general cargo containers. Whether the contents

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[7]Ibid., p. 598.

are loaded and emptied by gravity or pressure, the container will include tank openings, pressure relief mechanisms, gauging devices, insulation and heating and refrigeration machinery. To achieve international uniformity there must be standardization to ensure that hose fittings are compatable with tank openings and relief valves, that power sources may be attached to heating or cooling systems and that gauges are comprehensible to anyone who must read them.

Testing for maximum pressure capacity and both internal and external restraint features will provide a uniform measure of satisfaction to the users of any tank container which serves in international commerce.

The introduction of both fixed and rotary wing aircraft which are capable of moving intermodal containers is responsible for the introduction of Part Seven of this standard. Technical Committee 104 coordinated its effort with Technical Committee 20 (Air Craft and Space Vehicles) to ensure that consideration of intermodal capabilities did not impact on the safe operation of either the cargo planes or helicopters.

Other than a special marking, a simplistic but obvious fixed wing aircraft, which identifies the container as one which is capable of being loaded into aircraft, the design and testing requirements are similar to those specified for general cargo units. Containers which are suitable for air shipment should not be included in stacks of more than two containers.

ISO Standard 1161-1979 - Specification of Corner Fittings for Series One Freight Containers. This standard is closely aligned with

ISO Standard 688, which governs the actual containers. The corner fittings and the associated engaging devices are covered by separate United States patents which have been released by the patent holders for use in creating and developing the international standard.

Sea-Land Service, Incorporated has been assigned United States Patent 3,042,227 for the corner fittings. A normally configured container is constructed with a corner fitting inset at each corner in such a manner that the three exposed sides of the fitting are flush with respective exposed sides of the container. The exposed sides of the corner fitting are scored with holes of a standard size to allow the insertion from various directions of standardized lifting hooks.

United States Patent 2,963,310 has been issued to the Strick Trailer Company for an engaging device utilized to lift containers. In a fashion similar to the Sea-Land action with regard to corner fittings, Strick has allowed this patent to be utilized to develop standardization. Strick also holds United States Patent 3,004,772 which has not been surrendered to accommodate standardization, for a device which will facilitate end-to-end coupling of containers.

ISO Standard 790-1973 - Marking of Series One Freight Containers. Three standard shipping container markings have been adopted by the ISO. These markings are arranged in a specific format and must be affixed to the containers in designated positions to ensure that shippers, freight forwarders and other handling agencies are able to rapidly match a box with shipping document, bill of lading or invoice information.

The first is the eleven position ISO Code which is comprised of three parts. The owner code is a sequence of four capital letters which identify the entity which actually owns the container. The serial number is a six digit set of numerals which identifies the container among those owned by a specific company. The check digit is one numeral used for security or shipment validation purposes.

The Country Code - Size and Type Code provides information which is useful to customs agencies as well as shippers, handlers, loaders and storers of containers in a seven position combination. The country code is three capital letters which identify the country in which the owner is represented. The size and type code, quite literally, expel any doubt about the size of the container and its type. Users, handlers, and shippers are expeditiously able to determine how a container must be moved, stored and connected, if necessary, in either storage or transit.

The Maximum Gross and Tare Weights are both presented in pounds and kilograms. The maximum gross indicates the weight of the container and its contents when it is fully loaded. The tare weight is representative of the weight of the empty container.

Specific locations are identified on each container for placing of various codes and markings.

The ISO Code is placed on the container in six conspicuous locations. It is imprinted on the right-hand door of the container, in the upper right-hand corner of each side and the closed end, and at each end of the top parallel with the end of the container. This system

allows identification of the container from any viewpoint, including the hatch of a ship as the container rests in the hold.

Three locations on the container exhibit the Country Code - Size and Type Code. It is placed under the ISO Code in each instance, on the right-hand door and in the upper right hand corner of each side.

Maximum Gross and Tare Weight information is placed in only one location on each Series One Container, under the Country Code - Size and Type Code on the right-hand door.

ISO Standard 2716-1972 - Identification Marking Code for Freight Containers. This standard provides guidance for marking containers other than the Series One containers governed by ISO Standard 790. It is closely melded with Standard 790 inasmuch as it specifies the identical format for the owner code, serial number, check digit, country code, and size and type code; and indicates where they should physically be located. It does not require the weight information which is included in Standard 790.

This particular standard was developed with close attention paid to the marking systems rolling stock of railroads and to the requirements of automatic data processing systems which had been previously implemented. The standard allows the easy integration of containers into railroad systems and data processing programs.

ISO Standard 2308-1972 - Hooks for Lifting Freight Containers of up to Thirty Tonnes Capacity - Basic Requirements. For purposes of safety and to reduce damage to containers, their contents and lifting equipment, this standard describes the physical requirements for a

hook to be utilized with the corner fittings described in Standard 1161. Each of the four hooks utilized to lift a container must be vertically suspended from the corner of a lifting frame which is equal in dimension to the top of the container, or must be attached to a lifting chain which is constructed in accordance with ISO Standard 2308 (prepared by ISO Technical Committee 111). The lifting frame or set of lifting chains is then attached to a block and tackle suspended from the crane or other device capable of moving the container.

The hooks which are inserted into the corner fittings are common throughout industry and manufactured by many local foundries around the world. A hook which meets all specifications of the standard and is acceptable for use in lifting containers should be imprinted or marked "CONT 8t" along the side.

ISO Recommendation 830-1968 - Terminology Relating to Freight Containers. Six general areas of definitions, characteristics and specifications are included in this recommendation to ISO Member Bodies.

The "Freight Container" and "General Purpose Freight Container" are each defined in detail. A specific point is made in this section to emphasize that vehicles and conventional packing are not included in definitions of a freight container.

In terms of characteristics, a freight container may be noncollapsible, rigid in construction; or may be collapsible, which allows folding or disassembly/reassembly.

Maximum gross weight, tare weight, maximum payload, actual gross weight and actual payload are defined.

Iteration of the static and dynamic effects of the stresses of payloads, handling equipment and shipping procedure are included in the five load factors considered: floor load, end load, side load, roof load and super-imposed load.

The six measurements of freight container dimensions and volume are all offered in either linear or cubic terms, as indicated. Dimensions (height, width and length), overall external dimensions (including permanent external attachments), and internal unobstructed dimensions are linear measurements of the physical container. Displacement (volume as determined by measurement of overall external dimensions), unobstructed capacity (internal unobstructed volume), and capacity (the total volume based on all internal measurements) are cubic quantifications relating to the container.

Seventeen structural members and fittings which, when combined, comprise the "box" which is the container, are identified in this final segment of the recommendation: corner structures, corner fittings, lifting or securing eye, end frame, end wall, side frame, side wall, roof rails, bottom side rails, end door, side door, roof, base, cross members, floor, skids, and fork pockets. Several of these components are found in every container, two compose an either/or proposition, and others are optional at the discretion of the manufacturer or based on the style of the container. Every container has a base; but if it has doors, there will be only one set on either an end, or a side; and it may or may not have skids and fork pockets.

Summary of Standardization. Sixty-two member bodies and eighteen correspondents represent their nations or governments in the ISO. The

copyrights to the ISO Standards and Recommendations belong to the members and are controlled within the respective countries by the national representatives. The only valid standard within an individual country is the national standard for that country.

D. CONSTRUCTION OR MODIFICATION OF CONTAINER CARRIERS

Significant changes and alterations in the design of transportation vessels or vehicles were required to allow the advantages of "shipment by box" to be realized. Selected older ships have been restructured to accommodate containers in the holds and on the decks of a break-bulk or tanker hull. As capital becomes available to finance new construction, increased capacity, strength and durability are gained by building the container carriers from the keel or wheels to the kingpost or the top.

1. Maritime Modification and Construction

Through the initial growth period of containerized maritime shipping, two American lines, Sea-Land and Matson, dominated the trade routes. They began by converting older cargo ships to serve their containerized requirements. The two innovators approached containerization differently and the strengths of their development have been adopted as industry norms and standards throughout the world. In the early days of container shipping, both Sea-Land and Matson established some peculiar operating characteristics which remain as their particular idiosyncracies.

a. Sea-Land Ships and Shipbuilding

To advertise the new approach to shipping and to emphasize the intermodal ability of one company to provide door-to-door service to its customers, Malcolm McLean changed the name of his shipping company from Pan Atlantic Steamship to Sea-Land Service, Incorporated.

Based on the success of container carriage demonstrated in the 1956 experiments to ports in the Gulf of Mexico and Caribbean Sea, Sea-Land converted six C-2 type cargo ships from break-bulk to full container configuration. Each of six units was able to transport 226 thirty-five foot Sea-Land containers. Four of the vessels operated between ports on the United States' East Coast and the Gulf of Mexico and two served Caribbean routes. One unique feature of the Sea-Land organization was, and remains, the use of the thirty-five foot containers, the height of which, at eight and one-half feet also varies from the ISO standard. Since Sea-Land ships carry predominatly Sea-Land containers, the company has not accomplished the modification to its ships, containers and handling equipment which would be required to conform to international dimensions.

Sea-Land's extensive shipping network is served by sixty-seven ships which carry 62,000 company owned containers to 135 ports and destinations. Four general categories of vessels are utilized by the company to accomplish "direct" and "feeder" waterborne transportation.

In addition to the original conversion of six C-2 class ships, three of which remain in operation, nine other classes of converted cargo and tanker hulls are operated by Sea-Land. The capacity

of these ships ranges from the 225 container full load of the C-2Xs to a 609 limit of the C4J type hull. The twenty-nine conversions were accomplished as the industry grew and blossomed between 1957 and early 1970.

The capabilities of the individual ships reflect the maturation of port service capacities and harbor facilities at the various terminals served by Sea-Land ships. The first three classes of conversions, which were completed prior to 1964, are all equipped with two mounted gantry cranes. This feature was imperative in the early days of container shipping when port cranes capable of maneuvering thirty ton containers were not commonplace. As ports became more involved in the container business, dock-side and pier-mounted cranes were installed to attract container shipping and move containerized cargo. Accordingly, the final six classes of Sea-Land conversions were constructed without shipboard cranes. The older, smaller ships are still the trailblazers of the fleet, since they remain able to provide container service to ports which cannot accommodate ships without cranes. This versatility is extremely important to the world's developing nations which might otherwise be deprived of materials and products essential to growth and advancement.

Eight of the nine classes of converted Sea-Land ships have the capability to control the temperature of from fifty-six to one hundred of the loaded containers. Temperature sensitive containers must be loaded into the ship to allow access to the power source for heat or refrigeration. Two methods of cooling are utilized, and both

involve installation of machinery within the container. Mechanical evaporator coils with circulation fans such as the Thermo-King brand units provide versatility in nearly any mode of transportation since they are adaptable to gasoline, propane, diesel, hydraulic and electrical power sources. Self contained chemical or gaseous cooling systems also provide an efficient and extremely refined method of controlling temperatures within a very narrow band. The choice of temperature control system is based on the capabilities of the ship, the number of intermodal changes necessary, the distance of the journey, and the type of cargo involved. These options broadly expand the market for foodstuffs and perishable chemicals and drugs, by providing access to outlets which could not be reached by conventional methods of shipment.

The twelve Sea-Land ships with the greatest capacities have been constructed by the company as linehaul container vessels and are included in two classes. The four SL-18 Class carriers are able to load 733 containers, with the capability to control the temperature of 152 of them. The eight largest Sea-Land ships, of the SL-7 Class, can carry 1,096 boxes, and refrigerate 102 of them.

General cargo, break-bulk hulls have been characterized as discriminatory against cargo, "The propulsion machinery, navigating bridge and crew accommodations were invariably located in the full, comfortable midbody of the ship. The space left over was good enough for the cargo."[8] Conversely a full container ship is characterized

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[8]Ebel, Case Studies in Maritime Navigation, p. 2.

as "...a single purpose vessel with special arrangements for carrying containers in all available spaces..."[9] Sea-Land's fully containerized ships like most others "...do not need to have cargo handling gear as they operate only from special terminals which have the equipment for dealing with container traffic."[10]

Four converted ships of the Mosbay Class, which operate under the Norwegian flag, complete the line-up of forty-eight linehaul vessels. These ships are each capable of transporting 290 containers of which thirty-five can be cooled.

Because sixty of the 135 locations served by Sea-Land are connected into the worldwide network by "feeder vessel service", nineteen Fleet Feeder Vessels provide the transportation between feeder ports and those which provide direct vessel service. Feeder vessels are relatively small, conversion ships ranging in size from the 266 unit "Grand Navigator" to the twenty-six container "Rio Haina". The average capacity of these short-run, versatile ships is 108 containers, and they provide Sea-Land service to such ports as Boston, Massachusetts; Philadelphia, Pennsylvania; Lisbon, Portugal; Kingston, Jamaica and Bangkok, Thailand.

Two characteristics of the Sea-Land development are noteworthy. The use of thirty-five foot long, eight and one-half foot high containers has restricted, somewhat, the flexibility of the company's hardware within the industry, since other ships and material

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[9]Munro-Smith, Merchant Ship Types, p. 141.

[10]Ibid.

handling equipment are geared to the ISO standard lengths and heights. Secondly, among the "trailblazing" container companies, Sea-Land was the forerunner in relying on shipboard facilities for loading and unloading equipment. Sea-Land has generally accepted some costly installation, maintenance and operating expenses associated with shipboard mounted cranes to expand its operation and generate service to virtually any shipping customer.

b. Matson Navigation Company

Matson was the initial seagoing shipper to decide, internally, that containerization was a viable alternative to break-bulk cargo. Virtually all ships are economically most efficient when they are underway in the open ocean, and least efficient when they are in port. Matson concluded, after extensive research, that the time spent in port could be reduced and, more effective sailing time generated if containerization was adopted.

Unlike Sea-Land, Matson's ships never carried their own cranes. Although the Matson volume was high, they served only a few Pacific Ocean ports which were all equipped by the company with cranes and handling gear necessary to move Matson's containers. By utilizing twenty-four foot long containers, Matson adapted to West Coast highway requirements which facilitated the transfer to trucks, and allowed the company to better serve its customers.

The Matson fleet consists of fifteen ships, ten owned and five on charter. Ten are utilized exclusively for containers, three can be loaded with containers and vehicles and two are Roll-on/Roll-off

(RO-RO) vessels which transport container hauling trailers from port to port.

"It is not easy to explain why the Matson/Sea-Land success was ignored for so long by other shipowners, and why such a large number of lines eventually plunged into containerisation in the mid-1960s."[11] Regardless of the reasons it had previously been ignored, when the remainder of the shipping industry began to utilize the innovation, it was widely and immediately accepted.

From the rather humble beginning in 1956, through the slow growth period into the mid-1960s, to the present, the growth of an industry with 295 container ship operators has added a new dimension to the profiles of ships at sea.

Three specific types of containerized vessels are currently produced in lieu of conversions which were utilized to satisfy the initial demand for ships capable of securely moving containers.

c. Fully Containerized Vessels

These specialized ships may be either conversions or constructed for container configuration. They are cellular in nature with installed angle bars to guide the loaded container into its proper position and hold it in place laterally and longitudinally. Most fully containerized vessels are capable of carrying stacks of six containers in their largest holds, with the number decreasing toward the extremes and in the areas of machinery and other landed shipboard equipment. In addition to the boxes which can be loaded into the hulls, container

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[11]Johnson and Garnett, The Economics of Containerisation, p. 13.

vessels are capable of compensating for the loss of internal space by loading the weather decks with stacks of secured containers which are three or four high.

An automatic ballast and list equalizing system is an innovation which allows loading and discharge of containers to proceed at a rapid rate during the ship's port call. Water ballast is either added or removed from tanks in the sidewall structure of the ship to compensate for the container load in any configuration. During periods of time when the ship is underway, the sidewall and double bottom ballast tanks and mounted stabilizers maintain the stability based on the load, the sea state and the speed and direction of the ship. In newer ships, adjustments may be made automatically in response to inputs from sensors which monitor every salient variable.

d. Partially Containerized Vessels

A common configuration among ships which move vehicles over water routes is the partially containerized arrangement. In addition to the portions of the ship which are designed specifically to carry containers are the loading and internal ramps, and finished decks to allow the vehicles to be driven into the ship, secured during transit, and driven from the ship at the destination.

Automobile manufacturers frequently employ this method of shipment when exporting vehicles to overseas markets. The cars are simply driven into internal areas of the ship which are free from sea water spray and the effects of ocean storms, and chocked or secured with chassis cables.

In areas of the world such as the Baltic Sea/North Sea, Mediterranean Sea or South China Sea, where the oceanborne portion of a shipment may be shorter than the overland trip, it is often considered preferable to move an entire truck or tractor-trailer combination than to handle individual containers. The partially containerized vessels are ideally suited to accommodate customers desiring this service by allowing them to individually Roll-on and Roll-off. Movement through customs in an international journey and liability for certain types of loss or damage to the cargo remain the responsibility of the shipping agent or a representative freight forwarder rather than being shifted to the ship as they would in the case of a detached container.

Partially containerized vessels allow the shipper the choice of shipping mode, and provide the flexibility of decision making, which may be vitally important to a customer who requires various services but may not desire others.

e. Convertible Container Ships

With respect to the container carrying portion of the structure, these ships are not convertible. They are vessels which are equipped, in the manner of a fully containerized ship, to carry a portion of their load as containers, and to carry the remainder as general or bulk cargo.

They have practical applications in transporting material which is not amenable to containerization either because it is not easily loaded into a container or because more efficient use of the internal space of the ship can be achieved by loading it as break-bulk.

2. Railway Containerization Methods

In many societies and economies, intermodal freight service or land bridge operations are synonymous with linkages between maritime shipping and railroads. Containerized service on railways is available on all continents except Antarctica and is an integral link in commercial shipment whether it involves maritime shipping or not.

The concept of containers being attached to and detached from flatcars is the oldest form of containerized shipping, and one to which shippers and railroads can easily adapt. For many years heavy machinery and industrial components have been moved by flat car, and stowable commodities have been shipped in box cars, refrigerated cars, tank cars or gondolas. Containerization as a facet of the railroad business combines the two by placing stowable raw materials or finished merchandise into containers which are subsequently secured to a flat car for shipment to the destination.

Other than designing cars which would more accurately serve as a bed for a container of a given size, very little modification or adaptation was performed on the rolling stock of railroads. Flatcars which have been designed to haul containers are capable of carrying either sixty, seventy-five or eighty feet of maximum container length, and some have been fitted with rollers in the beds to assist container movement.

3. Motor Freight Containers

Although truckers have been reluctant to endorse containerization due to the investment within their own industry in trailers which are essentially containers with affixed wheels, their cooperation to

some degree is essential to most intermodal shipments. With the exception of some containers which are delivered to the consignee on railroad industrial sidings, the vast majority must be delivered by truck whether the journey is a few hundred yards from dockside or a few hundred miles inland.

To facilitate this hauling, a special trailer, known as a bogie, has been developed. A thirty ton container, while relatively light when added to a train of cars, is a very heavy highway load. The bogie is as light in weight as a trailer with a capacity for such an enormous load can be. It is a trailer frame which allows the container to be positioned securely on a set of double I-beams which are mounted on as many sets of dual wheels as necessary, and which hitches onto the tractor through a conventional fifth wheel installation.

For moving smaller sized containers, the bogie arrangement, minus the fifth wheel, can be fabricated on the back of a large single unit truck cab and frame. These can also be adapted with heavy duty winches, rollers and a hydraulic lift in the manner of a conventional dump truck to relieve the necessity for cranes or other lifting equipment.

Except those bogie frames which are attached to cabs and drivetrains, the modifications in the motor freight industry to accommodate containers are the easiest to fabricate and the least expensive in terms of capital investment.

4. Aviation Containerization

The advent in the early 1970s of wide bodied commercial aircraft such as the Lockheed L-100 Hercules, L-500, and L-1011; the

Boeing 747 and McDonnell-Douglas DC-10 made it possible to include airlines in both the standardized container shipping industry and its intermodal aspects. The utilization of these immense planes as commercial transports has been closely tied to the airborne shipment of containers.

Like ships in port, planes on the ground are inefficient. By preparing and staging a shipment of containers to coincide with the arrival of a wide-bodied cargo plane, ground time can be reduced to less than one hour, the plane can be refueled, the crew changed, and another load can be moving to another destination.

Fuel costs for aviation transport are exorbitant, but this is the singular mode of shipment for some products to selected areas of the world, and is required to meet or exceed market demands for other products.

E. CONSTRUCTION AND MODIFICATION OF PORTS, TERMINALS AND INTERMODAL EXCHANGE FACILITIES

As long as trade has existed and commerce has flourished, a significant portion of it has been intermodal. Whether the shift has occurred from the back of an elephant to the back of a camel, as might have been accomplished in the travels of Marco Polo; or whether it is an exchange between such sophisticated machines as a thirty knot cargo ship and a Boeing 747 transport plane, intermodal commercial activity is involved.

Great cities and centers of commercial activity have historically been those which are innovators as ports and exchange facilities.

Within the United States alone, New York City and Oakland are the principal ports on their respective coasts which serve as points of intermodal cargo transfer between ocean-going ships and other forms of transportation. Chicago provides equivalent opportunities between Great Lakes ships and overland trucks and trains. Minneapolis and Kansas City are cities situated on major navigable rivers where barge cargo may be shifted to other forms of movement.

Throughout the United States and around the world port facilities and terminals capable of providing every aspect of container handling service have been established. In some instances, such as Charleston, South Carolina, a major facility operated by the South Carolina Port Authority, the port has been revitalized and invigorated by the advent of containerized shipping. Since World War Two, the Dutch have developed the Europoort at Rotterdam, the world's largest port, by implementing innovative concepts such as facilities to unload super-tankers and full-range containerized services.

Storage of containers which are either not in use, or are awaiting shipment requires extensive ground space near the port or exchange area. For this reason, ports such as Charleston and Rotterdam which are either extensively redesigned or built with containers as a fact of shipping life are preferred by shippers and shipping companies alike.

1. The Maritime/Railway Interface

In an extremely difficult economic period for railroads, the marriage between maritime and rail shipping interests to move containers has provided a measure of salvation. Railroads which have been

involved in either land bridge or containerized intermodal shipping arrangements have enjoyed varying degrees of success, or have not been financially harmed by the innovation.

The land bridge arrangements between the American President Lines and two railroads, Burlington Northern and Southern Pacific are currently very beneficial. The railroads are providing a service to the shipping company which allows it to compete favorably with foreign break-bulk shippers in the maritime trade between the Orient and the Atlantic and Gulf Coast ports of the United States. Concurrently, American President provides a significant volume of contract business to the railroads, which injects a measure of needed stability and operational certainty into their operations.

The American President Lines' close ties to the railroads are possible due to the availability of three West Coast ports which are equipped to rapidly unload container ships which dock there. Los Angeles, Oakland and Seattle have all converted to modern facilities and move the containers through the ports to waiting container-carrying railroad flatcars which are parts of trains destined for the East Coast. The time saved in moving containers from the ships, through the ports and customs, and onto trains is generally the factor providing American President Lines with a containerized competitive edge.

As a shipper utilizing the railroad services, American President conducts extensive monitoring and expediting of individual containers or railroad cars to ensure that its position as a leader in land bridge shipping is not compromised by quirks of railroad service.

To achieve an intermodal application within a single entity, the British Railway freightliner system was expanded to include four ships which regularly sailed from a specially designed and built container port, Harwich, on England's southeastern North Sea Coast.

Two fully containerized ships, "Sea Freightliner One" and "Sea Freightliner Two" were procured to provide service to Zeebrugge, Belgium. Containers were moved from Harwich to Rotterdam on two converted vessels, "Domburg" and "Colchester". "Such was the efficiency and regularity of the services that shippers found it more economical and time-saving to forward cargo for the Continent to Harwich, from as far away as Glasgow and Liverpool instead of using one of the more traditional short sea routes out of Grangemouth or Hull..."[12] From the Continental ports, the containers are rapidly transferred to Intercontainer, Interfrigo, or Novatrans trains which deploy them to their destinations throughout Europe.

"To obtain the best possible transit times, individual container consignments and small groups are normally carried on the widely developed network of TEEM (TransEurop-Express Merchandises) and TEC (Transports Europeans Combines) trains."[13] Additionally, Intercontainer Specialized Container Trains (TECE) are regularly operated between large maritime ports and other commercial centers. For example, five trains per week each way run between Amsterdam, Rotterdam and Milan, Italy. Ten times a week they connect Amsterdam; Rotterdam;

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[12]Whittaker, J.R., Containerisation, p. 52, Transcripta Books, 1972.

[13]Finlay, Jane's Freight Containers, p. 537.

Antwerp, Belgium and Zeebrugge. Paris is linked to Rotterdam via Antwerp five times a week, and twice weekly service is provided from the Dutch port to Le Havre, France.

Container connections between maritime and rail facilities are obviously well developed and have become crucial commercial centers in industrialized, consumer-oriented parts of the world.

2. Maritime/Motor Freight Interface

Motor freight, because it is infinitely more versatile than its track-guided land-bound competitor, the railroads, is widely and practically used in many intermodal situations involving containers. The economics of movement by truck in short haul situations dictate that containers which are consigned to recipients with proximity to the port be moved by motor freight. In view of the fact that the final portion of the journey of most containers is by truck, it is not surprising that a railroad segment is omitted in these situations.

Trucks are also extremely useful in maneuvering containers in older ports, generally those located in older, inner city areas, where railroad access is either limited or non-existent. Containers which are delivered to such piers and wharves are often destined to a consignee located only blocks or miles from the waterfront, and they are easily and quickly moved by truck. Delivery of containers in developing areas of the world is also frequently accomplished by truck due to the lack of railroad facilities adapted to handling containers. During the period of time that United States Naval Forces were stationed in Kenitra, Morocco, Lykes Lines and Prudential Lines container ships were

too large to enter the harbor. They would anchor as close to shore as possible, place the designated cargo in lighters (small maneuverable barges), and have it delivered to the appropriate delivery trucks which were waiting ashore.

The motor freight industry, through a European oriented body known as the International Road Transport Union (IRU), has been primarily responsible for international agreements which speed containerized cargo through customs checkpoints and guarantee that the containers continue to move toward their destinations.

Thirty-seven countries, twenty-seven in Europe and ten in the remainder of the world are represented in the IRU. Nine countries are benefactors of associate memberships held by representative trucking organizations.

Although the meetings of the IRU are primarily conducted to accomplish efficient movement of containers and other cargo through the many boundries which span the map of Europe, the United States, Canada and Japan, among the non-European industrialized nations are also represented. By building on the 1959 Transports Internationale Routiers (TIR) Convention basis, the IRU advocated a revision which became the New TIR Convention of 1975. A significant result of this agreement provides that the TIR Carnet, an international shipping and customs document, may be utilized to validate a container shipment from point of origin to point of destination regardless of whether the journey is entirely by road or not. The integrity of this system is recognized to the extent that vehicles can travel internationally "without

controls when crossing borders"[14] as long as they are enroute to an ultimate, specified and legitimate destination.

3. Railway/Motor Freight Interface

Among container-carrying modes of transportation, the railway and motor freight industries are the most naturally competitive. Because they each have specific geographical areas and product lines where they are respectively more efficient, it is highly unlikely that either will achieve an advantage which will drive the other from competition.

In certain areas of the container shipping industry the railroad and trucking interests must, and do, mesh. In those areas of the world where railroad facilities are available, it is more economical to move many containers simultaneously, in one train load than in many individual tractor/trailer truck combinations. This acquiesence to the railroads notwithstanding, the motor freight industry plays a vital role in moving freight containers from a manufacturer or producer to a train, and ultimately, at the destination moving it from the train to the recipient.

Trucks are able to indulge in long distance, transcontinental freight movement and often do, when the urgency of delivery requires a mode faster than a train, but not as quick as that afforded by aircraft.

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[14]Ibid., p. 541.

4. Aircraft Intermodal Interfaces

"Containers offer too many advantages for shippers as well as carriers to allow any obstacles to remain unsolved..."[15] It is in this spirit of optimism, that shippers, carriers, labor organizations and governments have developed many of the programs and physical plants which have allowed containerization to evolve into a common method of achieving efficient transportation.

The coordinating effort by the Port Authority of New York and New Jersey is an excellent example of planning and foresight. Rather than stifle containerization in Manhattan or other congested areas of the port complex the "containerport" was situated in Port Newark, New Jersey immediately adjacent to Newark's Airport. Use of the Newark facility for air freight and containerization is further evidence of effective use of resources and facilities, since the other large airports of Metropolitan New York City are thereby relieved of a significant portion of freight and are able to concentrate on commercial passenger service.

Runways of sufficient length to accommodate the large planes which must be utilized to carry containers are not generally as advantageously located as those in Newark. While the lack of a sufficient runway may prevent a direct link between oceanborne and airborne freight service, it does not detract from intermodal connections between aircraft and either railroads or trucks.

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[15]Rinaldi, Lawrence J., Containerization, The New Method of Intermodal Transport, p. 48, Sterling Publishing Company, Incorporated, 1972.

The motor freight industry enjoys a particular advantage, since virtually every large airport is served by either the Interstate Highway Network or a state or local freeway system which provides equivalent access. Trucks, then, directly deliver their containerized cargo to air freight terminals or to the aircraft as they sit on auxiliary runways or taxiing aprons.

In spite of the relatively high costs of aviation freight movement, which are directly associated with continously increasing petroleum prices, a portion of the container shipping market is dedicated to air freight services, and appears that it will remain for the foreseeable future. Whether the shipper desires the service as a matter of routine or whether it is arranged in response to emergencies or one-time options, it is required to meet market demands for various products, and considered to be worthy of the effort.

F. SPECIAL HANDLING EQUIPMENT NECESSARY TO MOVE CONTAINERS AND FACILITATE INTERMODAL EXCHANGES

Containers as an aid to rapid shipment quickly lose their advantages if they cannot be expeditiously moved or, even worse, if they must be unpacked in a ship or on a pier for lack of proper container adapted material handling equipment. As the maritime pioneers, Sea-Land and Matson. each discovered, the cranes to unload a ship must each be in position, either on the ship or the pier, to begin unloading as soon as the ship's port call begins.

In addition to cranes, however, as the intermodal aspects of containers developed, other lifting and moving devices were invented.

Some of them are peculiar to a certain type of ship, truck, plane or railroad car, and others are unique to the port, terminal or pier which is using it.

Specialized forklifts, hoists, trailers, barges and skids are all parts of the containerization revolution which have proved so useful. Forty-six companies, located in thirteen countries are involved in the manufacture, sales and distribution of container handling equipment. In addition, some very specialized machinery is produced in shipyards for installation in a particular ship, delivery to a terminal or port, or use within the shipyard itself.

1. Cranes

Particularly with regard to stowing and unloading ships and barges, cranes are important. The jobs would be virtually impossible to accomplish without them. Cranes utilized for various situations involving container handling are one of six types.

Shipboard mounted gantry cranes have been previously discussed in several contexts. They are valuable because they serve the ship on which they are installed wherever it may be docked regardless of the availability of other types of container handling equipment. They operate along tracks installed at the outer edges of the hatches and are able to move the lifting mechanism athwartships to exactly center it over the container to be moved. The drawback to these cranes is that they introduce an entirely separate dimension of maintenance to a ship, and are generally difficult and expensive to maintain in view of the constant stress of underway motion and continuous exposure to the elements of the open sea.

Dockside container gantry cranes, goliath type gantry cranes and free path gantry cranes provide unloading services to a ship from a pier or wharf. The dockside container gantry cranes are rail-mounted, and specially designed and rigged to move containers which weigh as much as thirty tons. They are able to handle other types of cargo with changes in rigging or slings.

Goliath gantry cranes are also track mounted and capable of moving extremely large loads; not limited to containers, although they are fully able to do so.

Freepath gantry cranes are highly mobile, as the name suggests, and able to maneuver on rubber tires or wheels to a ship which may be inaccessable to a track constrained crane.

General purpose harbor cranes and mobile cranes are normally configured as boom cranes rather than gantrys and may be utilized for some ship-side work, but are more often found loading or unloading trucks and railroad cars.

2. Lifting Equipment

Three general types of lifting equipment are common in inter-modal exchanges of containers. Forklifts are probably the most widely recognized, although they must be large enough with a sufficient lifting capacity to stack heavy containers at least three high. Forklifts which are powered by electrical storage batteries, gasoline or butane/propane are configured to either load from the front or from the side, depending on the storage or access arrangment of the physical area in which they are working.

Straddle carriers, spreaders and container lifters all perform specialized container movement functions based on the requirements of the mode and types of containers with which they are working. Straddle carriers are designed higher, wider and usually longer than the load they are to carry. They simply maneuver in such a manner that the load is surrounded (straddled) by the lifting mechanism which performs its function and allows the vehicle to deposit the cargo in its designated destination.

Spreaders are designed for use with either cranes or forklifts, may be either manual or automatic, and are designed to keep a container level during its movement to ensure that packed cargo is not damaged by angles or tilts which may be imposed. When utilized with cranes, spreaders are of further importance because they level containers as they are being raised or lowered to ensure that they do not jam or bend the cell loading guides.

Other types of container lifters may "grab" a container from the side on the top and bottom frames to move it, while others may apply pressure to the opposite side or end frames to accomplish the left. Scissor lifts may be utilized to gain the mechanical advantage of a properly placed fulcrum and tail lifts on trailers, flat cars and platforms may also contribute to the movement of a container.

The most basic lifting method is the use of a series of floor jacks. When properly positioned under a container, they are used to lift and move it when necessary. This mode is recognized as archaic, but it is useful, particularly if the container has been stored indoors or in an area where access for larger lifters is limited.

3. Short Range Trailers, Barges and Skids

Certain trailers are not roadworthy for use on an interstate highway or even a city street, but they are adequate for use in moving a container around a port, terminal or runway. Similarly, semi-tractors which do not meet specifications for open road use are adequate for use in intermodal exchange areas, and log many miles staging containers for transit by other vehicles and vessels.

Barges which would never survive the high seas or even an extended river trip are frequently utilized to assist in container movement in areas where shallow water transit is necessary.

In an evolutionary development past containerization, large ships have been built which actually carry loaded barges, as forms of containers, from one port to another. These vessels are known generically as LASH (Lighter Aboard Ship) Ships and they have proven to be extremely useful in parts of the world where deep water ports and accesses are not available. By actually carrying the lighters in great numbers, rather than containers, several material handling steps may be eliminated as merchandise is delivered.

A typical LASH ship has a capacity of sixty-two barges, each of which is capable of carrying 371 long tons of cargo. The barges measure sixty-one and one-half by thirty-one by fifteen feet, and are individually loaded into the ship by a five hundred ton, rail mounted gantry crane which runs the length of the cargo deck.

Other types of skids, rollers, castors, skates, and runners have been developed especially to assist in the movement of containers. They too must be adapted to the environment in which they are used and

applied in conjunction with other types of container handling equipment to achieve maximum efficiency.

4. Lashing and Securing Equipment

Containers, by virtue of their standardized design, regular shape and dedicated shipping modes require very little in terms of exotic lashing and securing equipment. In ships they are guided into place, and laterally and longitudinally positioned by the use of guide rails or tracks. As a further precaution against movement within a stack of containers, stacking adapters which fit into the holes of the corner fittings and which are flush with the top and bottom frames of the containers are used. Other types of locks and cable hooks are used to secure containers at sea.

In truck and railroad applications, the containers are loaded into appropriate sized bases on bogies and flatcars and secured to the frame with cables, bindings, winches, ratchets or combinations of them.

Airlines utilize the devices employed by other modes, inasmuch as they stack containers, but not in the same manner that ships do. The containers are guided into place in frame structures, but are held there with apparatus similar to that utilized by their overland counterparts.

III. THE MODERN LAND BRIDGE AS A PRODUCT OF CONTAINERIZATION

Although it has connotations which are associated with the darkest recesses of geological and biological history, the concept of a land bridge as a facilitator of the movement of people and trade has evolved and matured with civilization. Modern land bridges provide an effective alternative to conventional shipping practices by utilizing the many assets of the container industry for producers, material handlers and customers.

A. GEOLOGICAL AND BIOLOGICAL HISTORY OF LAND BRIDGES

Algal and bacterial existence on Earth has been documented in rocks known to be three billion years old; however, life on land did not develop until the Silurian geological period 2.6 billion years later. For nearly two hundred million years, life flourished on a single landmass, Pangaea, which was composed of the seven current continents. In the late Triassic Period, Pangaea split into northern Laurasia and southern Gondwanaland which isolated the developing life forms in each area.[16]

As further expansion of the continents occurred, each on its own giant crustal plate, plants and animals indigenous to those regions

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[16]Wilson, J. Tuzo, "The Shaping of the Continent" in Our Continent - A Natural History of North America, Inside Back Cover, National Geographic Society, 1976

thrived. Europe and Asia never separated after breaking with North America. Australia and Antarctica never rejoined another landmass.

Three geological land bridges, two of which still exist, rejoined previously separated continents and provided the access for flora and fauna to move freely from one area to another. The most biologically important of the three is the Bering Land Bridge, which no longer exists, between Asia and North America.

Ironically, the Bering Bridge may have been formed by the creation of the Panamanian Land Bridge between North and South America. The latter bridge was formed by buckling plate movements between the two continents, which stymied free flowing of water between the Atlantic and Pacific Oceans. "Some scientists speculate that this interruption of temperature moderating currents may have changed the weather enough to trigger an ice age."[17] Since the Bering Bridge was definitely the result of a four hundred foot reduction of sea level as the Earth's water was concentrated in massive ice age glaciers, a logical explanation for its creation is that it might be a direct result of the Panamanian upheaval.

The Suez-Sinai Land Bridge between Asia and Africa provided an opportunity for biological movements between those two continents. The harsh climate of the Arabian and Sahara Deserts, however, prevented migration of the magnitude experienced to and from North America.

The most notorious "exports" from North America to Asia and the other eastern continents were horses and camels, both of which flourished and evolved in their new environments, but became extinct in

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[17]Ibid., p. 47.

their original home. Horses became llamas in South America, and were subsequently domesticated in Europe and Asia. Camels, the "horses of the desert" range throughout the arid portions of Asia to the Atlantic Coast of Africa.

The animal movement toward North America across the Bering Bridge would also have profound impacts on the Americas. With the mastodons, giant lions and saber-toothed cats came nomadic human beings. All were stranded on their new found continent as the ice age terminated, the glaciers receded, and the Bering Land Bridge was inundated. They, like the subarctic evergreens and deciduous forests in which they lived, continued to evolve or become extinct in much the same manner as their European and Asian counterparts.

The Panamanian and Suez-Sinai Land Bridges continue to provide access to migrating lifeforms, though the trek has been somewhat complicated by the construction of canals through each of them.

B. TRADE ACROSS LAND BRIDGES

Early traders learned that advantages could be gained by traveling the shortest route between two points, or the paths of least resistance. To save thousands of miles of travel by water, it was profitable to change modes of shipment, traverse a land bridge, reload the material, and reship it by water. The opposite of this also happens to be true, when goods which are nominally shipped over land can be expedited by being ferried across short stretches of water.

Control of the land bridges and access points became crucially important to commercial, as well as well as nationalistic and military interests of the European countries which explored and colonized the rest of the world beginning in the fifteenth century.

As the Spanish claimed and occupied the Isthmus of Panama to solidify their settlements and trade in the New World, English raiders Francis Drake and Henry Morgan continuously harassed Spanish shipping, attacked their towns and periodically came ashore and killed the inhabitants. In 1879 France attempted to gain a stronghold on the isthmus, "...when the builder of the Suez Canal, Ferdinand de Lesseps, came to inspect and inspire his new waterway project with a prophecy: 'The Canal will be made':"[18] de Lesseps was correct, but the canal crossing the land bridge was completed in 1914 after the French sold their rights and equipment to the United States. The American government supervised the construction and operation through establishment of the Panama Canal Zone.

Land bridges of early trade were not limited to narrow strips of land between oceans. In northern Minnesota, the Grand Portage National Monument preserves an area where fur trading, canoe paddling, eighteenth century voyageurs transferred their craft and cargo between the waterways which flow north via the Red River to Hudson Bay and the rivers which flow south and east through the Great Lakes toward the Atlantic Coast.

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[18]McDowell, Bart, "The Panama Canal Today", National Geographic, v. 153, p. 280, February 1978.

Throughout Europe, including the Soviet Union, canals have been built to facilitate traffic between the river systems and to eliminate the necessity to change modes to traverse a land bridge.

C. CONTEMPORARY LAND BRIDGE METHODS

The land bridge as a natural phenomenon and as an economic facilitator of trade is a fact of history. Like the life forms which crossed the Bering Bridge and the canals which make it possible to transit Suez and Panama, the land bridge concept continues to grow, mature and flourish.

Unlike earlier transportation land bridges, which crossed narrow isthmusses or strips of land, modern land bridge operations facilitate world-wide movement of cargo by crossing the broadest continents at their widest points by rail or motor freight.

Definitional distinctions are drawn between land bridges, mini-land bridges and micro-land bridges. A land bridge is considered to be that portion of a material movement which occurs over land between two waterborne shipments. An example of this type might be the shipment of electronic components for oil drilling equipment from Japan to Nigeria. The shipment could conceivably leave Yokohama, Japan by ship; arrive in Oakland where the components would be transferred to a train bound for New Orleans, Louisiana; and be retransferred to another ship transiting to Lagos, Nigeria. The portion of the trip from Oakland to New Orleans would be considered the land bridge.

The mini-land bridge, or mini-bridge, is a movement of material from one port to another which is distinguished by a lack of waterborne

transit on one end of the movement or the other. A shipment of skateboards from Los Angeles by rail through New York City and by ship to Liverpool, England would qualify as a mini-land bridge movement. The distance traveled by the material in any mode has nothing to do with the generic name of the shipment type. A mini-land bridge shipment may be four times as long in total distance as a land bridge shipment, but involves only one change of transportation mode rather than two.

A partially oceanborne intermodal shipment between two points, one of which is not a sea port, constitutes a micro-land bridge, or micro-bridge, shipment. Movement of petitgrain, an organic perfume base, by truck from land-locked Asuncion, Paraguay to Buenos Aires, Argentina for ocean shipment to Marseille, France is an example of a micro-land bridge transfer.

The air bridge provides a fourth "bridge" method of shipment which has become very popular for many types of small maufactured or finished goods as well as for valuable or perishable raw materials. The air bridge is intermodal in the same manner as the generic types of land bridges, but replaces at least one leg of an otherwise surface transit with an airborne shipment. In many remote parts of the world where roads and tracks have not been laid, and ocean transit is impossible for one reason or another, the air bridge provides a singular link for commerce and travel.

IV. THE INDUSTRY AS IT CURRENTLY EXISTS

Far from being an industry which has reached its apex or is on the decline, containerized shipping could, rather, be classified as one which has grown to the stage where refinement and specialization dominate its progress and provide the impetus for innovation. Because containers are so versatile and because they add such a vital dimension to the panorama of world trade and economic interaction, the container industry has drawn the attention and attracted the interest of an increasingly broad range of participating groups and agencies.

In addition to the customer who needs assistance to move merchandise and the shipping agency which can provide that service, governments, labor unions, regulatory bureaus and military missions are active in assuring that they are not forgotten when the benefits of containerization are realized. While consensus among such diverse groups is not always immediately generated, it is rarely unattainable, which has been responsible for dissemination of containerized cargo movement in one form or another to every continent and nearly every inhabited area of the Earth.

A. PARTICIPANTS IN CONTAINERIZED MARITIME SHIPPING

In some parts of the world the distinction between government and industry is not a clear one, while in others the government clearly dominates industrial enterprise or vice versa. As indicated in the

previous chapter, there are nearly three hundred participating ship operators alone, not to mention the various railroads; numerous motor freight organizations; and uncounted port, harbor and terminal services activities. This vast amalgamation of container movers is essentially divided into two factions. Governments of municipalities, states or provinces and nations preserve their integrity in some areas by shuttling containers from one point to another. Private companies or industrial concerns are motivated by the profits to be gained and recognition achieved through inclusion in the register of container shippers.

1. Governmental Participation

Municipal or local area activity in a port or terminal is more commonly limited to management of the facility as an intermodal exchange point than as a shipper or a carrier. The various shipping modes must be accorded access to each other, which may require, in some facilities, that container handling equipment be provided and that short distance moving service be available from the port or terminal. Hauling and movement services may be provided either directly by the facility itself, or they may be contracted to independent companies which serve the customers of the port as required or demanded.

Large ports such as the Port Authority of New York and New Jersey, which is spread across Metropolitan New York City in both states, allow shipping agents or freight forwarders to privately arrange for handling services and/or transportation for their customers.

Except in cities which are independent or essentially so, such as Singapore or Hong Kong, municipalities and local conglomerates are seldom involved in any long range aspects of containerized shipping.

To reap the benefits of containerized shipping, state port authorities often assist in underwriting or otherwise financing the construction of a container port facility. The aforementioned case of Charleston in South Carolina is an example. The involvement of the state is primarily administrative within the confines of the port and boundries of the state. As a matter of course, the state will rarely become engaged in any shipping or transit which transcends those limits.

National governments, unlike their smaller counterparts are active in nearly every aspect of containerization in one country or another. Government agencies such as the Maritime Administration in the United States and the Maritime Credit Corporation either provide subsidies, guarantee loans or offer direct financial assistance to organizations which might not otherwise engage in development of the commercial fleets or merchant marines of their countries.

National ownership of shipyards is not uncommon. The Indian government directly controls the Hindustan Shipyard at the city of Visakhapatnam on the Bay of Bengal. Recent events in Poland have dramatized that direct government ownership of shipyards, such as the V.I. Lenin operation in the Baltic Sea port of Gdansk, is not the panacea which solves all difficulties associated with construction of the largest vehicles to travel the face of the planet.

The vessels themselves are frequently owned or influenced by governments or government agencies. It goes without saying that the commercial fleets of the Soviet Bloc Eastern European nations are state owned and operated. Among the less socialistic countries, the "...French policy of a certain amount of state control in those industries which are in the national interest..."[19] is representative of a keen governmental concern for the condition of companies which support the commonwealth. The French government is the principal owner of Compagnie Generale Transatlantique which is an active participant in container carriage.

Virtually every nation which is bounded by the sea, and some that are not, is involved in registration of ships to fly under its flag. Some countries, most notably, Liberia, Panama, Greece and Somalia offer "flag of convenience" registration, which virtually assures that their merchant fleets will be foreign owned, but also creates a positive impact on balance of payments ledgers through the generation of registration fees and tonnage taxes.

Because container vessels are an innovation in the merchant shipping business, and since they are relatively new and usually heavily subsidized, few of them are registered under flags of convenience. Ships are often extended docking privleges and harbor services in the countries in which they are registered. "Flag of convenience" ships may receive no preferential treatment or possibly no treatment at all depending upon their registry, point of voyage origin and cargo.

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[19] Maritime Subsidies, p. 40, United States Department of Commerce, 1974.

It behooves a container ship to be assured of rapid access to a port, prompt services at the berth and expeditious egress to ensure that underway time is maximized and port calls limited. In the maritime container industry, flags of convenience may be an anachronism which are, in fact, inconvenient. National governments which subsidize or own container carriers usually insist that they be registered under the flag of that government.

Unlike port facilities in the United States which are administered by various levels of government, most ports in the remainder of the world are controlled by the central governments of the nations in which they are located. In some instances, foreign ports are independent businesses, and in others they are top-to-bottom governmental operations, but the management in either case is more closely aligned with the central administration than with local politicians.

2. The Participation of Private Enterprise

From the basis established by Sea-Land and Matson when they commenced maritime container shipping, emerged many other enterprises intent on sharing the profits associated with the new mode of shipping. Similar to the broad scope coverage of the industry by governments, entrepreneurs entered every aspect of the containerized shipping business and have continually expanded to create new methods, hardware and services.

Construction of and conversion to container ships has generated significant contracts for the private shipyards of the world. The explosive growth of the industry in the latter half of the 1960s was paralleled by energetic activity in shipyards capable of accepting the

increased demand for the specialized ships. For the shipyards which had the capacity, and needed the business, the container ship building period was a relative boom. Many private shipyards, which are employers of large numbers of technically trained and highly skilled workers, were receiving government subsidies to alleviate economic stagnation when orders for container carriers were received. Since container ships are mechanically quite basic with few frills and since the demand was high, the proft margins for their construction reduced the requirement for governmental assistance, and fostered economic vitality in the companies which were able to accept contracts. Northern European shipyards in Sweden, West Germany, the Netherlands and the United Kingdom were in particularly good positions to build container fleets. The container revolution assisted Japan in maintaining its position as the country with the largest shipbuilding industry in the world. United States shipbuilders such as the Newport News Shipbuilding and Drydock Company also benefitted tremendously from the opportunity to engage in a diversified form of production.

Around the world, shipyards and drydock facilities in the vicinities of container ports are able to profit from the requirement that the ships must remain underway to remain efficient. By being available to provide repair and maintenance services in conjunction with a ship's port call, they are able to reduce the amount of time a ship is inactive and thus unproductive.

The shipping companies are the most visable entities within the container industry. Ships in port or on the horizon and containers

traveling on bogies or railroad flatcars advertise their presence on a global scale. The breadth and depth of involvement of a shipping company varies based on the service functions performed. A total service, full-range, door-to-door shipping organization, such as Sea-Land or Matson controls every aspect of the container movement. The boxes are company owned, they are moved to intermodal exchange areas by trucks which are owned by or leased to the company, and they are loaded onto company ships at company piers by company container handling equipment. After the trans-oceanic journey, the process is generally reversed at the destination port, and total control is exercised and exposure gained from the delivery process. These companies, among many similar operations world wide, actively solicit business and continuously innovate as they compete.

Intermediate service companies may be involved in trans-oceanic carriage on a charter basis with a small fleet of ships, or may provide long-range ferry shipping coupled with some container handling support. The options which might be exercised by an enthusiastic, locally oriented operator are limited by the requirements of the market, the availability of entrepreneurial capital and the ability to produce the service as it is needed.

At the opposite end of the spectrum from total service organizations are small carriers. These operators of small converted ships or ferries, are capable of moving small loads of containers among other forms of cargo between closely situated ports which are separated by narrow bodies of water. The Strait of Gibralter between Algeciras,

Spain and Tangier, Morocco; and the Ore Sund which separates Copenhagen from Malmo, Sweden are international examples of areas served by this type of company. Rather than having to solicit the trade, it is naturally directed to them by geography and they operate to fulfill the short-range transportation needs of their assorted customers.

Under various types of agreements, contracts or leases in the United States, Japan and most industrialized countries of Western Europe, port facilities may be operated by private enterprises which must solicit container shipping business and provide the required port services. The connection between these companies and different levels of government is very close for several reasons. The overall scope of port operation is normally controlled by a governmental authority, bureau or commission which grants an operational license or charter to a company to conduct specifically defined operations within specified areas of the port or terminal.

Secondly, because containers are facilitators of world-wide trade and enhance smooth movement through customs procedures, terminal operators must provide international customs representatives with schedules and work spaces to guarantee prompt and accurate inspections.

Independent stevedore and longshore services may be provided in instances when neither the shipping company nor the port facility is capable of conducting the container handling phase of the cargo movement.

A more recent group of participants than those which have been associated with the industry since its inception are container leasing organizations. By making containers available to shippers which do not

conduct enough container shipping business to warrant owning boxes, or by supplying containers to shippers, agents, or shipping companies which are temporarily in short supply, lessors have proven to be important and valuable cogs in the gear train of commercial activity. Approximately sixty companies in the European Common Market, the United States, Japan, Hong Kong and Switzerland are involved in container leasing.

B. PARTICIPANTS IN LAND BRIDGE AND INTERMODAL OPERATIONS

As the transportation network which serves the container shipping industry spreads and as more participants enter the competition, the distinctions between government activity and private enterprise tend to become blurred. Governmental organization in the overland and airborne facets of transportation is as comprehensive, as is its involvement in maritime shipping. Consequently, governments and private businesses are actively involved and thoroughly intertwined in the growth of land bridge and intermodal shipping activity.

1. Participants in Land Bridges

Land bridge shipping is a specialized form of intermodal transit which depends on containers, and the rapid shipboard loading and unloading technology associated with them, to gain competitive advantages in the delivery of merchandise and raw materials. While land bridge shipping is possible without containers, it is not practical and is therefore rarely considered in any other context.

Because of their natural dependence on shipping as a mode of transportation and trade, the island and enclave economies of the

western Pacific Ocean are involved in more land bridge shipping than the remainder of the world. Japan is the unquestioned leader in all types of land bridge shipping. The Japanese utilize two land bridges for transportation to Northern Europe and the United Kingdom. Shipments to either Oakland or Vancouver, British Columbia on the western coast of North America initiate the first alternative. Railroad transit to either New York City or Montreal, Quebec accomplishes the overland portion, and reshipment across the Atlantic to the destination port completes the journey.

The second land bridge option available to the Japanese is less well known, but is a viable alternative to them. Westward ocean shipment across the Sea of Japan to the Soviet ports of Vladivostok or Nokhodka provide links to the Trans-Siberian Railway and ultimately the Baltic Sea port of Leningrad. Further short ocean trips will deliver the Japanese commodities to Scandanavia, Germany or the United Kingdom.

Japanese mini-land bridge shipments follow essentially the same routes, except that goods destined for eastern North America are not reshipped in New York or Montreal; and material provided to central and southern Europe remains in rail transit across the Soviet Union to its destination.

Other Oriental economies which take advantage of the land bridge forms of material movement across the Pacific are the island nations of Taiwan, the Philippines and Indonesia, as well as isolated enclaves such as South Korea, Hong Kong and Singapore.

Another interesting application of the land bridge concept involves the unlikely consortium of Australian wool producers, Israeli

truckers, and Greek and Turkish spinners and finishers. The bulk wool is shipped from Australian ports to Elat in southern Israel on the Gulf of Aqaba in the Red Sea, trucked across the country to the Mediterranean port of Ashdad, and reshipped to the processors in Greece and Turkey. This is one of few examples where motor freight rather than railroads provide the transportation over land.

2. Participants in Intermodal Containerized Shipping

Whereas, all land bridge shipments are intermodal, the opposite is not true and the others must then be categorized according to the type of intermodal interface involved. Intermodal trade is not dependent on any particular aspect of commerce, in the manner that land bridges require containers. The most intensive concentration of intermodal container activity, however, is located in the industrialized segment of the Northern Hemisphere where vast quantities of raw materials and consequent finished goods are freely shipped from producer to user.

Trade routes which do not require the sophistication of a land bridge, are often served by a simple intermodal connection which links a rail or motor freight shipment to a ship at a convenient port. This type of interface is common within the industrial economies of Europe and between those economies and the United States. The geography of Europe, which directs trade across many channels and straits causes many intermodal changes which are not required when transiting equal distances in other parts of the industrialized world.

C. LABOR ORGANIZATIONS AND THEIR INFLUENCE

For many of the same reasons that labor availability delayed the arrival of containers on the scene of international commerce, containerization was viewed by various cargo handling and moving labor organizations as mechanization designed to displace workers. In virtually every port where containerization has become established, an obstacle which has required resolution has been the participation of stevedores and longshoremen in the benefits of the changing environment. The gains which accrued to the shippers and shipping companies from having container ships in port for short periods of time corresponded to lost opportunities for the workers, who were compensated for doing in two days an effort which previously required two weeks.

1. Labor Relations in the United States

Two labor unions provide the work force of people who "work the waterfronts" of the United States. In the Atlantic and Gulf Coast ports, workers are represented by the International Longshoremen's Association (ILA). The International Longshore Workers Union provides representation to people who work in Pacific Coast ports. Although there have been strikes on both coasts, and labor grievances directly related to containerization, "...American West Coast pacts are taken by some as evidence that port productivity deals can be successfully negotiated without undue ill-effects to either party..."[20]

The substance of the agreements reached in American ports was based on restructuring the work routine to correspond to container

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[20]Johnson and Garnett, The Economics of Containerization, p. 81.

handling operations, ensuring that the work force would be retained at a guaranteed wage and sharing with the established workers any monetary benefits gained through modernized operations. These agreements were deemed acceptable for the most part and they served to keep ports operating and workers employed during the transition which accompanied containerization. In those areas where the work force was reduced, it was accomplished through natural attrition rather than forced unemployment. The continuous growth of the container shipping segment of cargo carriage has served, in a sense, to overwhelm what might, in the past, have been sporadic disputes. The volume is so heavy and the flow so steady in many ports that people who are specialists in container handling and movement are continually occupied.

The Vietnam conflict provided a tremendous volume of military traffic through West Coast ports and was at least partially responsible for the smooth transition in the West. The transition on the East Coast has not been as smooth, however, where a 1977 strike was directly related to the container issue, and where a late 1980 walk-out may be caused by a similar impasse. Although seventy-five percent of the 1978 general cargo which passed through the Port Authority of New York and New Jersey was containerized, some basic issues regarding containers and their cargo remain unresolved on the East Coast. Attempts by employers to reduce the sizes of labor gangs working on the docks have been resisted by the ILA. The intransigence of the union on the issue of container stuffing has also accounted for strikes which have closed ports.

2. Labor Relations outside the United States

From Sea-Land's origination of containerized service in the Caribbean, overseas strikes and work stoppages have caused changes in the wage levels received by the workers who have loaded and moved the boxes. The initial Sea-Land service to Puerto Rico was delayed for several months while agreements were negotiated with the longshore labor force in San Juan. "Insufficient planning - principally the failure to obtain cooperation of longshore labor in Venezuela"[21] doomed the Grace Line's attempt at establishing the first large scale, fully containerized foreign trade. That experience in 1961 was echoed along waterfronts throughout the world for the next decade as the container industry grew, spread, became accepted, and provided monetary and work environment benefits to workers as well as the other participating groups.

In the United Kingdom, where labor unions have been particularly ruthless in advocating labor policies which have driven solvent companies into bankruptcy, shippers and shipping operators were forced to accept some counter-productive and expensive labor practices to gain the opportunity to have containers handled at all. Ships bound for ports in England were diverted to Rotterdam and Antwerp where the containers were unloaded, placed in other ships and shuttled to their original destinations. The disputes were based on labor principles which ranged from having nothing to do with container handling per se, to objecting to having to handle them and ensuring that union registered dock workers had stuffed them. The losses in time and additional

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[21]Ebel, Case Studies in Maritime Navigation, p. 9.

expenses incurred in foreign handling and reshipment obviously reduced the gains which otherwise would have been realized.

Containers were so widely accepted, however, that they ultimately became the solution to longshore unemployment in London and Liverpool, Britain's two ports with the worst labor-relations records. By sheer volume, container shipping has fostered in each port, work opportunities which would have been lost without the technological advances.

Unmechanized ports remain in labor intensive areas of the world. The large Indian ports of Bombay and Calcutta are the most graphic examples, where tens of thousands of dockworkers observe time-honored traditions of unloading ships or containers by manual labor using as little machinery as possible. "In Bombay, an automatic grain loader rusted away on the dock while the longshoremen continued to bag grain by hand as they had always been accustomed to doing."[22] The prospect of efficient use of containers in ports such as these will become a reality only if the worldwide usage becomes so overwhelming that there is no alternative. The productivity of an individual worker is so low, and they are so numerous, that any form of mechanization will drive a disproportionate number of them from the ranks of the employed without commensurate opportunities for retraining and reemployment.

D. CONTAINER REGULATORY AGENCIES

The blending of material movement functions through the use of multi-modal innovations such as trailers-on-flat cars, containers-on-

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[22]Ibid., pp. 22-23.

flat cars, and entire tractor-trailer combinations on RO-RO ships has caused jurisdictional disputes within the industry and governmental regulatory bodies. The resolution of conflicts by international treaty, national legislation or industrial agreement is the foundation upon which trade grows and further innovations are erected. Because many competing groups often have vital interests at stake, the regulatory decisions are not easily made, accepted or implemented, but they must ultimately be recognized as the guidelines of an area of trade and commerce.

1. International Regulation

No individual group such as the United Nations or the World Court dominates international container regulation with nearly the strength that is applied by voluntary compliance with the guidelines of organizations such as the ISO, Intercontainer or the IRU. These "governing bodies" of their respective aspects of world trade are headquartered in Western Europe and are composed of legitimate representatives of the various nations which comprise their memberships. They provide a modicum of rationality toward achieving multi-national stability among the singular interest of participating countries.

The viability of a container as a reusable vehicle for international, intermodal transportation has been established as a result of standard sizes, compatible handling equipment and interchangeable modes of basic propulsion. Basic rates for container transportation between two points, the ability to utilize standardized shipping documents, and rapid processing through intermediary customs procedures are further

benefits derived from agreements reached by international, extra-governmental, regulatory organizations.

2. National Regulatory Agencies

Regulation in the form of binding legislation or administrative edict is much more easily enacted or decreed by a national government than at a higher level. Virtually every nation of the world includes departments or ministries of commerce, transportation and foreign affairs within its bureaucratic hierarchy. Each of these branches of government is interested in directing the welfare of its nation to the advantage of the people as well as to the enhancement of its organizational stature. As a result, transportation regulation has evolved into an extremely complex genere of law within which the participants must operate, and remain informed and flexible.

Within the United States, which is a member of most international regulatory bodies, the interaction among the various internal agencies is no exception to the pattern instituted elsewhere. The Department of Transportation was created in 1967 to provide the President with a cabinet level organization to develop national transportation policies and programs. The department is limited inasmuch as it is empowered with few regulatory or jurisdictional prerogatives, but it enjoys ready access to the Congress of the United States, where administration policies and ideas become formulated into laws and guidelines.

The Interstate Commerce Commission, the Federal Maritime Commission and the Civil Aeronautics Board are statutorily created to act as judge and jury with regard to the economic aspects of surface and

air transportation respectively. They must interpret the legislative mandates of the Congress and establish the guidelines within which the various transportation and carriage activities function. Recent laws which have sanctioned deregulation of various components of the transportation industry in the United States have reduced the regulatory powers of the agencies, but they remain intact as monitors of the deregulation as the competitors develop their own internal or private regulations.

The Federal Maritime Administration is established within the Department of Commerce to advocate the development of the United States' Merchant Marine capabilities. Two general facets of the Maritime Administration program include the subsidization of ships designated as United States flag ships, and subsidization of the wages paid to the merchant seasmen who serve in the nation's merchant marine force.

3. Industry Regulation

In many respects the internal regulation of an industry which is subjected to as many external forces as is the container shipping business is a reflex action to those various forces. It is probably true though that some pricing, routing and physical standardization would evolve whether the carriers were subject to myriad international and governmental guidelines or not. As they are currently structured, and as deregulation becomes more broadly integrated, the various components of the transportation industry rely heavily on non-profit carrier-maintained rate bureaus or conferences to establish collective pricing. The rate bureaus are specifically exempted from anti-trust

prosecution, and perform a legal and useful service to their subscribers, subject to the review of governmental regulatory agencies.

Unlike the rate bureaus which function within one country under the jurisdictional review of the cognizant government, "A shipping conference is a group of lines, jointly maintained, which co-ordinates sailings to give a regular service, and whose members agree to charge freight at conference rates."[23] Conferences are generally established in areas where high shipping density exists, such as the North Atlantic or the United Kingdom - Far Eastern Freight Conference. In other areas such as the heavily sailed North Sea, conferences do not exist and rates and routes are extremely competitive.

The advantages of conference activity are evident to both the carrier and the shipper. The regularity of sailings and stable shipping prices provide both parties with the information necessary to allow them to plan their operations to best serve their own needs and those of their customers. Conference schedules may periodically deprive a shipper of the best available rates, or may force a carrier to forego the pleasure of a one-time high profit venture. Carriers periodically withdraw from conference association and attempt to compete independently against all other competition. In an era when transportation deregulation is sanctioned and encouraged, such action has been viewed by some participants as both prudent and profitable. Sea-Land has recently withdrawn from the East Bound United States Conference, an action viewed by some participants as an invitation to a "rate war".

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[23] Whittaker, Containerisation, p. 44.

4. Military Involvement

In many respects, the volume of container shipping generated by the United States Department of Defense is viewed as the single factor which proved the viability of the method and made the capital investment worthwhile. The overseas shipment of personal household goods has been accomplished by packing furniture, appliances and other possessions into containers, properly marking the boxes and moving them, by any convenient mode toward their destination.

The aforementioned distress of Defense Department personnel, that valuable material was either being destroyed by weather or pilfered as it sat open on the piers of the world was alleviated by the Army Transportation Corps. It was determined that forty percent of military cargo "...could be containerized to good advantage."[24], and the Army developed and introduced a standard sized Conex box which was completely intermodal. By the height of the Vietnam conflict two hundred thousand Conex containers were owned by the Army and the Air Force and "...full containership services using van-sized containers were introduced to Viet Nam in 1967."[25] Carriers which were involved in or observed the Vietnam support operation recognized that containers were remarkably versatile, provided excellent cargo protection, and allowed a much greater proportion of time underway to time spent in port than was previously available. For the many adverse impacts that it had on the psyches of the American population and the image of the United

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[24]Ebel, Case Studies in Maritime Navigation, p. 6.

[25]Ibid.

States as a military force, the Vietnam conflict provided the opportunity to prove the value and effectiveness of containerized shipping.

In a vastly different, but equally important, and current, aspect of military operations, containerization as a support function in Europe of the North Atlantic Treaty Organization (NATO) is one of few components which is standardized. Among the treaty members, but particularly between the United States and the other allies, standardization of military hardware and support components is the greatest obstacle to a cohesive force which might effectively counteract a strike by Warsaw-Pact nations. Since all NATO signers are represented in the ISO Technical Committee 104, container standards should be assured throughout the alliance.

V. THE FUTURE OF CONTAINERIZATION

Containerization is past the evolutionary stage of having to prove its utility. Like any other enterprise, however, the industry must pursue a vigorous program of expansion, research and development to retain its position as a stalwart in the cargo moving and transportation fields.

Expansion will be possible into the developing and industrialized areas of the world where the demand for finished goods and industrial components will be rapidly rising. Increased containerized shipping capacity, additional port/terminal facilities and new container handling equipment will have to be available to accomplish these goals. The financing of these heavily capital-intensive projects will have to come from companies which are certain of return on investment or countries which are certain of stability and growth potential.

Containerization, with its cargo protection advantages and intermodal capabilities, offers too many benefits for an industrial or developing economy to ignore. The technology to support expansion is available, and broader, deeper market penetration will provide the opportunity to expand the industry to the limits of its geographical bounds.

Research will be applied to every aspect of the container business to consistently pursue more efficient utilization of the material assets and management capabilities of the industry. Seaworthy

ships will be designed and built to more closely maximize hold and deck space utilization. Propulsion plants which are more efficient energy and fuel users will be fabricated and installed within the ships.

Three designs for improved features in various aspects of container handling equipment are listed by Jane's Freight Containers as representative of the refinement and versatility which can be included in the container movement process. In ports which are congested, or where inadequate stationary container handling facilities have been installed, "Portafloats" have been offered by two British companies as a solution. These large barges are capable of accepting virtually any cargo, but are especially well adapted to containers since they can carry twenty or thirty-five motor freight trailers from the shore to the ship's side. The cargo is then loaded from the ship directly onto flatbed trailers or into gondola or staked trailers. If necessary, the cargoes may be "...sorted, palletised, and customs-cleared..."[26] on the barge prior to delivery ashore. The barges are automatically ballasted to maintain an even keel under any load conditions. Water is automatically pumped from tank-to-tank or tank-to-sea to compensate for the weight and placement of any load on the deck of the barge.

To provide rapid loading and unloading capabilities for widebodied, container carrying aircraft, a truck cargo bed has been built which accepts an aircraft container from the vessel's elevator, rotates it into the appropriate moving position on an installed turn-table, moves

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[26]Finlay, Jane's Freight Containers, p. 644.

it with grasping rubber rollers and secures it for transit by raising it slightly above the rollers within side-mounted guides.

Automated movement of containers and other cargo through warehouse facilities to staging points has been enhanced by the development of an omni-directional limit type switch which senses movement from any angle along the track. The one switch assembly replaces multitudes of single-directional installations which can sense in only one direction in one movement plane.

The containers themselves are becoming increasingly sophisticated as additional experience in using them is gained. More reliable self-contained refrigeration and preservation systems are engineered as demands to move more commodities longer distances are generated.

The most elaborate use of containers involves the incorporation of several standard ISO units into mobile, self-contained refrigeration systems. These transportable plants can be established either ashore or aboard ship, and are capable of providing refrigeration to as many as seventy-two other containers which require cooling from -25°C to 13°C against any ambient temperature condition. The compressor, condensers and other cooling components are installed in one twenty foot container. The ducting is mounted in forty-two foot containers, each of which may be connected to twelve cargo boxes by the use of pneumatic couplings.

As the industry becomes more mature, more research will be applied to the development of alternatives and refinements which will continue to provide shippers with the opportunities to utilize containers to move their raw materials, finished goods or production equipment. In

addition to the hardware which comprises the physical movement portion of the system, complex and detailed planning is required to ensure that the proper ships, trucks, cranes, forklifts and containers are available at a designated point as they are needed.

Unlike World War Two "Liberty" and "Victory" ships which were fabricated in days and weeks, the cargo ships of the last quarter of the twentieth century require months and years to construct after the decision to build has been made, and funding obtained. Extensive forecasts of ship tonnage and hull requirements for each category of shipping are presented, studied and considered before the decision is made to commit millions of dollars of capital to a ship prototype or class. An example of the procedures which govern such a forecast is the following:

> The methodology, which is used in conjunction with a cargo forecast, has four key steps. First, the cargo forecast is allocated by commodity to vessel types on a trade route basis. Second, the size distribution within each vessel type is determined and the cargo by vessel type is assigned to size groups. Third, the cargo assigned to each vessel type-size group is used to compute the appropriate number of vessels required to carry it. This requires the calculation of the annual carrying capacity of each size and type of vessel. Fourth, once the number of ships in the entire fleet serving U.S. trade is computed, the number and type of U.S.-flag vessels is determined. After each fleet forecast for a particular year, the methodology allows for the scrapping of overage vessels and the updating of the parameters in the forecasting process for the subsequent forecast year.[27]

In many of the larger ports and intermodal excahnge facilities, hundreds of individually marked containers sit, awaiting shipment to

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[27]Marcus, Henry S.; Sclar, Michael L.; Wise, Randall E. and Lisnyk, James A., A Methodology for Forecasting the Fleets to Serve U.S. International Commercial Trade Until the Year 2000, presented at the Annual Meeting of The Society of Naval Architects and Marine Engineers, New York City, New York, 11-13 November 1976.

the appropriate destination. A methodology or system is required to coordinate container inventories and requirements with ship movements, port services and intermodal exchange opportunities. Data processing programs are consistently developed and refined to attempt to ensure that every factor relating to those containers is considered when a decision is made to load any of them into a particular position in a particular ship, or to allow them to remain on the wharf until another opportunity is presented. Obviously, the assignment of priorities is extremely germane, as is an ancillary system which tracks lost or misrouted boxes.

VI. SUMMARY

Far from serving as the wonder medicine to cure all shipping and cargo handling ills, containerization may act as an antigen to thwart the increasingly common maladies which have recently afflicted world wide shipping - shipping fraud, and more violently, ship scuttling. False letters of credit and ghost cargoes are the key elements of the former, while the sinking of a ship after its cargo has been deposited at an undocumented port is the essence of the latter.

Because containers are identified by unique numbers which are utilized throughtout the industry and in customs procedures; and because their numbers facilitate tracking and control of the boxes, and their contents, the opportunity for the direct application of fraud through either non-existent cargo or cargo shuttled to a black-market port is greatly reduced.

Like today's "pirates with briefcases" who have evolved from the swashbucklers of the era of exploration, containers, container transportation, and the methods utilized to join them have evolved from natural and economic beginnings which have led to today's access to their benefits.

Containers in shipping were developed in 1830. They were virtually dormant for 125 years due to economically feasible alternatives. The worth of a container on a ship was demonstrated in 1956 and by 1970, containers had begun to be standardized to accommodate all forms of

movement. Through the decade of the nineteen seventies, the standard boxes were refined to allow carriage of nearly any type of cargo in nearly any environment by nearly any mode of transportation.

Ships were converted or constructed to carry only standardized containers, ports and terminals were modified or built to accept container carrying vessels or vehicles, and both were equipped with installed or portable container handling equipment designed to rapidly move the cargo from consignor to consignee.

Shipping companies have developed individual systems for container distribution. Some operate on small scales from pier to pier, others stress door-to-door service, and others are intimately involved in intermodal exchanges and land bridge service.

Virtually every country in the world utilizes containers in either international or intermodal shipping. Maritime shipping is accomplished by private companies, consortia of companies which have pooled their management or capital resources or directly by a bureau within the central government. Land bridge transit, which is a specifically defined category of intermodal carriage, provides interesting and innovative insight into the opportunities which are available to customers who consider all alternatives for moving cargo from one point to another.

In addition to the shippers who provide the cargo, the carriers which provide the vessels and the port facilities which offer handling equipment, the labor forces which move the cargo and the regulatory agencies which govern its movement play increasingly involved roles in

the overall scheme of containerized shipment. Containerization has necessitated a redistribution of the work effort which has forced people into new and unfamiliar positions which have, in turn, required retraining and familiarization programs.

Regulatory agencies have had to consider the new method of shipment as it relates to such diverse areas as customs procedures, cargo handling safety, shipbuilding subsidies and standardization within a new industry. The regulation has come from international commissions, industry conferences and governmental administration. The inevitable conflicts have been resolved, procedures legitimatized and the industry has continued to mature under the auspices and guidance of all concerned parties.

The United States military, particularly the Department of the Army, was one of the heaviest early users of containers. Their worth as protection against weather and pilferage has been demonstrated in climates from the Arctic to the Antarctic and in ports where theft and graft were otherwise accepted methods of operation. Military advancements in the field have closely paralleled those of other participants. This has elevated containerized shipping to one of the few areas within NATO operations and support activities where standardization is implemented and functional.

The future of containerization is as broad as the horizons over which containers can be moved. In addition to the current applications in existing hardware configurations, containers will be developed for extended space and oceanic explorations. Modular portable containers

which can be stowed "ashore" with proper mixes of equipment, food, spare parts and health supplies are critically important to adventures where stowage must be compact yet all inclusive.

As long as there is the movement of human beings, trade and logistics support will follow. To achieve the most satisfactory response to the requirements of people in their various environments, trade must follow the path which encounters the least total resistance. Containers are currently established as a vehicle over that path, and should remain as a leader for generations of travelers, traders and explorers.

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